

Revised Syllabus

For

ITI

WELDER



**LAL BAHADUR SHASTRI PARAMEDICAL SKILL
AND TRAINING COUNCIL, INDIA**

**लाल बहादुर शास्त्री पैरामेडिकल कौशल और प्रशिक्षण
परिषद, भारत**

मुख्य कार्यालय : 4वीं मंजिल, प्राइम प्लाजा, इंदरा नगर, लखनऊ

प्रशासनिक कार्यालय : द्वितीय तल, सुनील कम्पलेक्स, वेस्टर्न कचेरी रोड, मेरठ

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Exam :March and Aprail

(To be implemented from 2026-27 session)



Syllabus Of ITI “WELDER”

FIRST YEAR (1ST)

S.NO	Subject	Distribution Of Mark			
		TH	PR	Viva -Voce	Total
WT-101	Trade Theory	100	-	-	100
WT-102	Workshop Science & Calculation	100	-	-	100
WT-103	Engineering Drawing	100	-	-	100
WT-104	Welding Technology & Materials	100	-	-	100
WT-105	Practical Training	-	75	25	100
WT-PRS	Sessional Assessment (PRS)	100	-	-	100
	Total	500	75	25	600

FIRST YEAR(1ST YEAR)

RATIONALE

The **Welder Trade** aims to develop skilled professionals capable of performing welding and fabrication work safely and efficiently in industrial environments. The course provides comprehensive knowledge of welding principles, welding processes, engineering materials, workshop calculations, engineering drawing, safety practices, quality control, inspection methods, and maintenance of welding equipment.

The programme combines theoretical instruction with intensive practical training, enabling trainees to perform various welding processes such as **Shielded Metal Arc Welding (SMAW), Gas Welding, Gas Cutting, MIG/MAG Welding, TIG Welding, and basic fabrication**. It also emphasizes workplace safety, quality assurance, environmental protection, and industrial work ethics in accordance with NCVT standards.

CONTENTS

WT-101 : Trade Theory

Welding is a process of permanently joining two or more pieces of metal by using heat, pressure, or both, with or without filler material. It is one of the most important operations used in fabrication, repair, maintenance, and manufacturing work. In the ITI Fitter trade, welding is useful for assembling metal parts, repairing damaged structures, making frames, and preparing different workshop jobs.

The main purpose of welding is to create a strong and durable joint between metal pieces. A good weld should have proper strength, uniform appearance, and enough penetration to hold the parts firmly during service. Welding is widely used in industries such as construction, automobile, railway, shipbuilding, pipeline work, machinery production, and general engineering workshops.

In basic welding training, students learn the names and functions of welding equipment such as welding machine, electrode holder, electrodes, earth clamp, cables, welding table, chipping hammer, and wire brush. They also learn the importance of personal protective equipment such as welding helmet, gloves, apron, safety shoes, and goggles.

A beginner in welding must understand safety first. Welding produces heat, sparks, fumes, and intense light, so proper precautions are necessary to prevent burns, electric shock, fire accidents, and eye injury. Students are also introduced to basic welding operations such as arc striking, maintaining correct arc length, running straight weld beads, edge preparation, tack welding, and making simple butt and fillet joints.

Industrial Safety and PPE

Industrial safety means the rules, precautions, and practices followed in a workshop or industry to prevent accidents, injuries, fire, damage to machines, and loss of life. In an ITI Fitter workshop, many operations such as filing, drilling, grinding, welding, cutting, lifting, and machine handling can be dangerous if safety rules are ignored. Therefore, industrial safety is essential for protecting workers, tools, machines, and the workplace environment.

The main aim of industrial safety is to create a safe working condition. It teaches workers to use machines correctly, handle tools carefully, keep the workplace clean, avoid unsafe

behavior, and follow instructions properly. Good safety habits reduce accidents and improve efficiency, confidence, and discipline in the workshop.

Some important industrial safety rules are:

- wear proper protective clothing before starting work
- keep the workplace clean and dry
- use the correct tool for the correct job
- check machines before operating them
- never operate a machine without permission or training
- do not wear loose clothes near rotating machines
- immediately report damaged tools, broken wires, or unsafe conditions
- follow fire safety and first aid instructions
- switch off machines after use

PPE stands for **Personal Protective Equipment**. These are safety items worn by a worker to protect the body from injury during workshop operations. PPE acts as a barrier between the worker and workplace hazards.

Common PPE used in workshop and fitter trade are:

- **safety helmet** – protects the head from falling objects
- **safety goggles** – protect the eyes from dust, metal particles, and sparks
- **face shield** – protects the face during grinding and cutting
- **hand gloves** – protect hands from cuts, heat, and rough surfaces
- **ear plugs / ear muffs** – protect ears from loud noise
- **safety shoes** – protect feet from heavy objects, sharp materials, and slipping
- **apron / protective clothing** – protect the body and clothes from sparks, oil, and dirt
- **mask / respirator** – protect from fumes, dust, and harmful gases

In industrial work, PPE should always be selected according to the type of job. For example, welders need helmets and gloves, grinders need goggles and face shields, and machine operators need safety shoes and proper clothing.

Welding processes are the different methods used to join two or more metal pieces permanently. These processes use heat, pressure, or both to make a strong joint. Different welding methods are selected according to the type of metal, thickness of the job, required strength, cost, and nature of work.

The main types of welding processes are:

1. Arc Welding

Arc welding is the most common welding process used in workshops and industries. In this method, an electric arc is produced between the electrode and the workpiece. The heat of the arc melts the metal and joins the parts together.

Examples:

Shielded Metal Arc Welding (SMAW)

Metal Inert Gas Welding (MIG)

Tungsten Inert Gas Welding (TIG)

Uses: fabrication work, repair work, construction, machine parts, and structural jobs.

2. Gas Welding

Gas welding is done by using a flame produced by burning a fuel gas with oxygen. The most common gas welding method is **oxy-acetylene welding**. The heat of the flame melts the edges of metal and joins them.

Uses: thin sheet metal work, pipes, repair work, maintenance jobs, and light fabrication.

3. Resistance Welding

In resistance welding, heat is produced due to the resistance of electric current passing through the metal pieces while pressure is applied. No filler metal is usually needed.

Types:

- Spot welding
- Seam welding
- Projection welding

Uses: automobile body work, sheet metal industry, and mass production jobs.

4. Thermit Welding

Thermit welding is a special welding process in which heat is produced by a chemical reaction between aluminum powder and iron oxide. This process gives very high temperature and is used for joining heavy sections.

Uses: railway track joining, large steel sections, and repair of heavy parts.

5. Forge Welding

Forge welding is one of the oldest welding methods. In this process, metal pieces are heated until they become soft and then hammered or pressed together to join them.

Uses: blacksmith work, tool making, and traditional metal work.

6. Solid State Welding

In solid state welding, joining is done without melting the base metal completely. Pressure is mainly used, and sometimes a little heat is applied.

Examples:

- Friction welding
- Ultrasonic welding
- Diffusion welding

Uses: special engineering jobs, precision parts, and dissimilar metals.

7. Laser Welding

Laser welding uses a highly focused laser beam to melt and join metal parts. It is a modern and highly accurate process.

Uses: automobile industry, electronics, medical devices, and precision manufacturing.

8. Electron Beam Welding

This process uses a beam of high-speed electrons to generate heat for welding. It is carried out in a vacuum and gives deep, precise welds.

Welding Tools and Equipment

Welding tools and equipment are the instruments, devices, and accessories used to carry out welding work safely and correctly. They help in producing strong and proper welded joints. In workshop practice, a welder must know the name, use, and care of each tool and equipment before starting the job.

The main welding tools and equipment are explained below:

1. Welding Machine

The welding machine is the main equipment used to produce heat for welding. In arc welding, it supplies electric current to create an arc between the electrode and the workpiece. Welding machines may be AC or DC type.

Use: to provide the required current for welding.

2. Electrode Holder

The electrode holder is a hand tool used to hold the electrode firmly during arc welding. It is insulated to protect the welder from electric shock.

Use: to grip the electrode and carry current to it.

3. Electrodes

Electrodes are metal rods used in arc welding. They conduct electric current and also provide filler metal to the weld joint. Some electrodes are coated with flux to protect the weld from contamination.

Use: to form the arc and fill the joint.

4. Earth Clamp

The earth clamp connects the welding machine to the workpiece or welding table. It completes the electrical circuit needed for welding.

Use: to provide return path for electric current.

5. Welding Cables

Welding cables are thick insulated wires used to carry current from the welding machine to the electrode holder and earth clamp.

Use: to transfer electric current safely.

6. Welding Helmet or Hand Shield

A welding helmet protects the eyes and face from harmful rays, sparks, and heat produced during welding. It has a dark filter glass for safe viewing of the arc.

Use: to protect face and eyes during welding.

7. Safety Goggles

Safety goggles protect the eyes from sparks, dust, and flying particles during chipping, grinding, and gas welding work.

Use: eye protection.

8. Hand Gloves

Leather hand gloves are used to protect the hands from heat, sparks, and burns.

Use: hand protection during welding and handling hot jobs.

9. Apron

A leather apron protects the body and clothes from sparks, heat, and hot metal particles.

Use: body protection.

10. Chipping Hammer

A chipping hammer is used to remove slag from the weld bead after welding.

Use: cleaning the weld surface.

11. Wire Brush

A wire brush is used to clean rust, scale, slag, and dirt from the metal surface before and after welding.

Use: cleaning the joint and weld bead.

12. Welding Table

A welding table is a strong metal table on which welding jobs are placed and welded.

Use: to support the workpiece safely.

13. Pliers and Tongs

Pliers and tongs are used for holding hot metal pieces and small components during or after welding.

Use: handling hot jobs safely.

14. Grinder

A grinder is used for edge preparation, cleaning the weld, and finishing the welded joint.

Use: grinding and finishing work.

15. Gas Cylinder

In gas welding, oxygen and acetylene cylinders are used to supply gases for producing the flame.

Use: to provide gases for gas welding and cutting.

16. Pressure Regulator

The pressure regulator is fitted on the gas cylinder to control the gas pressure.

Use: to regulate gas flow safely.

17. Welding Torch

A welding torch is used in gas welding to mix oxygen and acetylene and produce the flame.

Use: to generate welding flame.

18. Hoses

Rubber hoses are used to carry oxygen and acetylene gas from the cylinders to the torch.

Use: gas supply connection.

Gas Welding

Gas welding is a welding process in which metals are joined by heating them with a flame produced by burning a fuel gas with oxygen. The most common gas welding method is **oxy-acetylene welding**, where acetylene gas burns with oxygen to produce a very high-temperature flame. This flame melts the edges of the metal pieces, and if required, filler metal is added to make a strong joint.

Gas welding is one of the oldest and most widely used welding methods for light and medium work. It is simple, portable, and useful for welding thin metal sheets, pipes, tubes, repair jobs, and maintenance work. It is also used in cutting, brazing, soldering, and heating operations.

Principle of Gas Welding

The principle of gas welding is based on the combustion of a fuel gas with oxygen to produce a controlled flame. The heat of the flame melts the base metal at the joint. A filler rod may be

added to fill the gap between the metal pieces. When the molten metal cools and solidifies, a permanent joint is formed.

Equipment Used in Gas Welding

The main equipment used in gas welding are:

- oxygen cylinder
- acetylene cylinder
- pressure regulators
- gas hoses
- welding torch or blowpipe
- filler rod
- spark lighter
- safety goggles
- gloves and apron

Types of Gas Flames

There are three main types of flames in gas welding:

1. Neutral Flame

This flame has a balanced mixture of oxygen and acetylene. It is the most commonly used flame for welding steel, cast iron, and many other metals.

2. Carburizing Flame

This flame has excess acetylene. It is used where a reducing atmosphere is needed, such as for high carbon steel and some non-ferrous metals.

3. Oxidizing Flame

This flame has excess oxygen. It is mainly used for brass, bronze, and gas cutting operations.

Advantages of Gas Welding

- simple and easy to operate
- portable and useful in field work
- low equipment cost
- suitable for thin metals
- can be used for welding, brazing, soldering, and cutting

- does not require electricity

Disadvantages of Gas Welding

- slower than arc welding
- not suitable for very thick metals
- lower welding speed
- more heat affected zone
- weld quality depends greatly on operator skill

Uses of Gas Welding

Gas welding is used for:

- sheet metal work
- pipe welding
- automobile body repair
- maintenance work
- fabrication of light structures
- brazing and soldering jobs

Safety Precautions in Gas Welding

- check hoses and regulators before use
- keep cylinders upright and away from heat
- do not allow oil or grease near oxygen fittings
- use proper goggles, gloves, and apron
- light the torch with a spark lighter only
- close valves properly after work
- work in a well-ventilated area

Gas Cutting

- **Gas cutting** is a process used to cut metal by using a flame and oxygen.
- It is mainly used for cutting **iron and steel** materials.
- In this process, the metal is first heated by a **gas flame**.
- After heating, a jet of **pure oxygen** is passed on the hot metal.
- The metal burns and melts, and the cut is produced.
- The most common method is **oxy-acetylene gas cutting**.
- It is used for **plates, rods, pipes, and structural steel**.

- Gas cutting is useful in **fabrication, repair, and maintenance work**.
- Main equipment used are:
 - oxygen cylinder
 - acetylene cylinder
 - cutting torch
 - regulators
 - hoses
 - spark lighter
 - wear goggles and gloves
 - check gas leakage before use
 - keep cylinders away from heat
 - use torch carefully

Arc Welding

- **Arc welding** is a welding process used to join metals by using **electric current**.
- In this process, an **electric arc** is produced between the **electrode** and the **workpiece**.
- The heat of the arc melts the metal and forms a strong joint.
- A **filler metal** may also be added through the electrode.
- Arc welding is commonly used for **steel fabrication, repair, and maintenance work**.
- It is one of the most common welding methods used in workshops and industries.

Main Equipment Used

- welding machine
- electrode holder
- electrode
- earth clamp
- welding cables
- welding helmet
- gloves and apron

Advantages

- strong joint
- simple process
- widely used

- suitable for thick metals
- faster than gas welding

Electrodes and Fluxes

- **Electrode** is a metal rod used in welding to carry electric current.
- It helps to produce the **arc** between the electrode and the workpiece.
- In arc welding, the electrode also supplies **filler metal** to the joint.
- Electrodes may be **consumable** or **non-consumable**.
- A consumable electrode melts and becomes part of the weld.
- Electrodes are available in different sizes according to the job.

Flux

- **Flux** is a coating or chemical material used on the electrode.
- It protects the molten weld metal from air, oxygen, and impurities.
- It helps to produce a **clean and strong weld**.
- Flux also forms **slag** on the weld surface.
- The slag protects the hot weld metal during cooling.
- Flux improves weld quality and arc stability.

Importance

- electrodes carry current and fill the joint
- flux protects the weld and reduces defects
- both are important for proper welding work

Welding Defects

- **Welding defects** are faults or imperfections found in a welded joint.
- These defects reduce the **strength, quality, and appearance** of the weld.
- Welding defects may happen because of wrong current, bad electrode, poor skill, dirt, or improper welding method.

Common Welding Defects

- **Cracks** – small breaks in the weld metal
- **Porosity** – small holes caused by gas trapped in the weld
- **Slag inclusion** – slag trapped inside the weld
- **Undercut** – groove formed at the edge of the weld

- **Overlap** – weld metal flows over the surface without proper fusion
- **Lack of fusion** – weld metal does not join properly with base metal
- **Incomplete penetration** – weld does not go deep enough in the joint
- **Spatter** – small metal particles scattered around the weld area

Welding Symbols

- **Welding symbols** are standard signs used on engineering drawings.
- They give information about the **type of weld**, **size**, **position**, and **length** of the weld.
- Welding symbols help the welder understand where and how welding should be done.
- They make the drawing simple and avoid writing long instructions.

Main Parts of Welding Symbol

- **Reference line** – the main horizontal line of the symbol
- **Arrow** – points to the place where welding is required
- **Basic weld symbol** – shows the type of weld
- **Tail** – gives extra information such as process or specification

Welding Positions

- **Welding positions** mean the different positions in which welding is done.
- The position depends on the **job**, **joint**, and **direction of welding**.
- Welding position is important because it affects the **quality** and **ease** of welding.

Main Welding Positions

- **Flat Position**

Welding is done from the top side of the joint.

It is the easiest and most common position.

- **Horizontal Position**

Welding is done on a horizontal surface or along the side of a vertical surface.

It is a little more difficult than flat position.

- **Vertical Position**

Welding is done in an up-and-down direction on a vertical surface.

It needs more skill and control.

- **Overhead Position**

Welding is done from the underside of the job.

It is the most difficult position because molten metal may fall downward.

Weld Joint Design

Weld joint design means the shape and arrangement of two metal pieces before welding. A good joint design helps in getting a strong, clean, and economical weld. It also makes welding easier, improves penetration, reduces defects, and saves time and material.

Importance of Weld Joint Design

- provides proper strength to the joint
- allows correct penetration of weld metal
- reduces distortion and cracking
- saves filler metal and welding time
- makes fabrication and assembly easier
- improves safety and quality of the welded structure

Main Factors in Joint Design

- thickness of metal
- type of material
- welding process used
- position of welding
- required strength of the joint
- accessibility of the welder
- cost of preparation and welding

Common Types of Weld Joints

- **Butt Joint** – two metal pieces are placed edge to edge
- **Lap Joint** – one plate overlaps another plate
- **T Joint** – one plate is joined at right angle to another plate
- **Corner Joint** – two plates are joined at the corner
- **Edge Joint** – edges of two plates are placed side by side and welded

Heat Treatment

Heat treatment is a process in which a metal or alloy is heated to a suitable temperature, kept at that temperature for a certain period, and then cooled at a controlled rate to change its properties. It is mainly done to improve hardness, strength, toughness, softness, machinability, ductility, and resistance to wear. Heat treatment is very important in engineering work because it helps metals perform better in different industrial applications.

The main purpose of heat treatment is to obtain the desired mechanical properties without changing the shape of the metal. By proper heating and cooling, the internal structure of the metal can be changed. This improves the quality and service life of tools, machine parts, shafts, gears, springs, cutting tools, and other engineering components.

Objectives of Heat Treatment

- to increase hardness
- to improve strength
- to increase toughness
- to reduce brittleness
- to relieve internal stresses
- to improve machinability
- to improve ductility
- to increase wear resistance

Welding Inspection

- **Welding inspection** means checking the welded joint to see whether it is correct, strong, and free from defects.
- It is done to ensure the **quality** and **safety** of the weld. Inspection helps to find faults like **cracks, porosity, slag inclusion, undercut, and lack of fusion**

Destructive testing

Non-destructive testing

Hammer test

Dimension checking

Visual inspection fusion.

- It also checks whether the weld size, shape, and position are according to the drawing.

Methods of Welding Inspection

- **Visual inspection** – checking the weld by eye
- **Dimension checking** – measuring size and shape of weld
- **Hammer test** – checking soundness of weld in simple work
- **Non-destructive testing** – such as radiography, ultrasonic test, dye penetration test

- **Destructive testing** – bending or breaking the test sample

Quality Control

- **Quality control** means checking and maintaining the quality of a product during and after production.
- It ensures that the finished job meets the required **standard, size, strength, and accuracy**.
- In workshop practice, quality control helps to produce good and defect-free components.
- It reduces mistakes, wastage, rework, and production loss.

Main Points of Quality Control

- checking raw materials before use
- checking dimensions during work
- using correct tools and machines
- following proper process and method
- inspecting the finished product
- removing defective pieces

Modern Welding Technology

Modern welding technology refers to the advanced methods, machines, and systems used for joining metals with better speed, accuracy, strength, and safety. It is an improved form of traditional welding and is widely used in industries such as automobile, shipbuilding, construction, aerospace, railway, oil and gas, and heavy engineering.

In modern welding technology, welding is done with the help of improved equipment, automatic controls, and special welding processes. These methods produce better quality welds, reduce human effort, save time, and increase productivity.

Main Features of Modern Welding Technology

- high speed welding
- better accuracy and quality
- less material wastage
- more safety for workers
- use of automatic and semi-automatic systems
- strong and clean weld joints

WT-102 : Workshop Science & Calculation

Units and Measurements

Units and Measurements form the foundation of engineering and welding technology. Accurate measurement is essential for fabrication, fitting, welding, inspection, and quality control. A welder must be able to measure dimensions correctly to ensure proper fit-up, joint preparation, and compliance with engineering drawings.

2. Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the concept of units and measurements.
- Identify SI units used in engineering.
- Perform basic unit conversions.
- Measure dimensions using standard measuring instruments.
- Read and record measurements accurately.
- Apply measurements during fabrication and welding work.

Engineering Mathematics

Engineering Mathematics provides the mathematical knowledge required for welding, fabrication, measurement, estimation, and engineering calculations. It enables trainees to calculate dimensions, material requirements, welding angles, load distribution, and production costs accurately in industrial applications.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand basic mathematical concepts used in engineering.
- Perform calculations related to welding and fabrication.
- Solve problems involving measurement and geometry.
- Apply mathematical formulas in workshop practice.
- Calculate material requirements and production costs.
- Develop logical and analytical problem-solving skills.

Fractions and Decimals

Fractions and decimals are essential mathematical concepts used in engineering, welding, fabrication, and workshop calculations. They help welders measure dimensions accurately, calculate material quantities, determine welding lengths, and interpret engineering drawings.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the concept of fractions and decimals.
- Convert fractions into decimals and decimals into fractions.
- Perform basic mathematical operations involving fractions and decimals.

- Apply fractions and decimals in engineering measurements.
- Use fractional and decimal values accurately during welding and fabrication work.

Percentage and Ratio

Fractions and decimals are essential mathematical concepts used in engineering, welding, fabrication, and workshop calculations. They help welders measure dimensions accurately, calculate material quantities, determine welding lengths, and interpret engineering drawings.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the concept of fractions and decimals.
- Convert fractions into decimals and decimals into fractions.
- Perform basic mathematical operations involving fractions and decimals.
- Apply fractions and decimals in engineering measurements.
- Use fractional and decimal values accurately during welding and fabrication work.

Geometry

Geometry is the branch of Engineering Mathematics that deals with the study of **shapes, sizes, angles, lines, areas, and volumes**. In the Welder Trade, geometry is essential for measuring materials, preparing joints, reading engineering drawings, fabricating structures, pipe fitting, and calculating dimensions accurately.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand basic geometric concepts.
- Identify different geometric shapes used in engineering.
- Calculate perimeter, area, and volume.
- Measure angles and dimensions accurately.
- Apply geometry in welding, fabrication, and layout work.
- Interpret

Trigonometry (Basic)

Basic Trigonometry is a branch of Engineering Mathematics that deals with the relationship between the **angles and sides of a right-angled triangle**. It is widely used in welding, fabrication, structural work, pipe fitting, layout marking, and engineering drawing. Trigonometry helps welders calculate angles, slopes, heights, distances, and dimensions accurately during fabrication and installation work.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the basic concepts of trigonometry.

- Identify the parts of a right-angled triangle.
- Calculate angles and side lengths using trigonometric ratios.
- Apply trigonometry in welding and fabrication work.
- Measure slopes, pipe angles, and structural dimensions accurately.

Heat and Temperature

Heat and Temperature are fundamental concepts in engineering and welding technology. They play a vital role in welding processes, metal cutting, heat treatment, and fabrication. A welder must understand how heat affects metals, welding quality, and the properties of materials to produce strong and defect-free welds.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the concepts of heat and temperature.
- Differentiate between heat and temperature.
- Identify different methods of heat transfer.
- Understand the effect of heat on metals during welding.
- Measure temperature using appropriate instruments.
- Apply heat control techniques in welding operations.

Strength of Materials

Strength of Materials (SOM) is a branch of engineering that deals with the behavior of materials when subjected to different types of forces or loads. It helps welders understand how metals and welded joints respond to tension, compression, bending, torsion, and shear stresses. Knowledge of Strength of Materials is essential for designing, fabricating, and inspecting safe and durable welded structures.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the basic concepts of Strength of Materials.
- Identify different types of forces acting on engineering materials.
- Explain stress, strain and elasticity.
- Understand the mechanical properties of metals.
- Apply Strength of Materials principles in welding and fabrication.
- Select suitable materials for different engineering applications.

Engineering Materials

Engineering Materials are the materials used in the manufacturing, fabrication, construction, and maintenance of engineering components. In the Welder Trade, knowledge of engineering materials is essential for selecting suitable metals, understanding their properties, choosing the correct welding process, and producing high-quality welded joints. Different materials behave differently during heating, welding, machining, and fabrication; therefore, understanding their characteristics is important for safe and efficient industrial work.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the classification of engineering materials.
- Identify ferrous and non-ferrous metals.
- Explain the physical and mechanical properties of materials.
- Select suitable materials for welding and fabrication.
- Understand the effect of heat on engineering materials.
- Identify common engineering materials used in industries.

Workshop Calculations

Workshop Calculations involve the mathematical calculations used in welding, fabrication, fitting, machining, and engineering workshops. Accurate calculations are essential for measuring materials, estimating costs, preparing layouts, selecting welding consumables, and ensuring precision in fabrication work. A welder must be able to perform basic engineering calculations to complete jobs efficiently and safely.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the importance of workshop calculations.
- Perform calculations related to welding and fabrication.
- Calculate dimensions, area, volume, and weight of materials.
- Estimate material and welding consumable requirements.
- Calculate welding time and production cost.
- Apply mathematical calculations in practical workshop activities.

Estimation of Welding Cost

Estimation of Welding Cost is the process of calculating the total cost involved in completing a welding job before production begins. It includes the cost of materials, welding consumables, labour, electricity, equipment usage, overhead expenses, and inspection charges. Proper cost estimation helps industries prepare quotations, reduce wastage, control production costs, and improve profitability.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the importance of welding cost estimation.
- Identify different components of welding cost.
- Calculate the cost of materials and consumables.
- Estimate labour and machine operating costs.
- Prepare a simple welding cost estimate.
- Apply cost estimation techniques in industrial fabrication projects.

WT-103 : Engineering Drawing

Drawing Instruments

Drawing Instruments are the tools used to prepare engineering drawings, sketches, layouts, and fabrication designs accurately. In the **ITI Welder Trade**, engineering drawings provide detailed information about dimensions, shapes, welding symbols, joint preparation, and fabrication details. Proper use of drawing instruments helps welders interpret drawings correctly and produce accurate fabrication work.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the purpose of engineering drawing instruments.
- Identify various drawing instruments and their uses.
- Handle drawing instruments correctly.
- Prepare simple engineering drawings and sketches.
- Maintain drawing instruments properly.
- Apply engineering drawings in welding and fabrication work.

Lines and Lettering

Lines and Lettering are the basic elements of Engineering Drawing. Different types of lines are used to represent the shape, size, dimensions, hidden details, and center lines of engineering components. Lettering is used to write titles, dimensions, notes, symbols, and specifications clearly on engineering drawings. Proper knowledge of lines and lettering enables welders to read and prepare fabrication drawings accurately.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the importance of lines and lettering in engineering drawing.
- Identify different types of lines and their applications.
- Draw standard engineering lines correctly.
- Practice standard lettering styles.
- Apply lines and lettering in welding and fabrication drawings.
- Interpret engineering drawings effectively.

Orthographic Projection

Orthographic Projection is a method of representing a **three-dimensional (3D) object** in **two-dimensional (2D) views**. It is one of the most important techniques used in engineering drawing to show the exact shape, size, and dimensions of an object. In the **ITI Welder Trade**, orthographic projection helps welders understand fabrication drawings, identify welding joints, prepare layouts, and manufacture components accurately.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the concept and principles of orthographic projection.
- Identify different projection planes and views.
- Distinguish between first-angle and third-angle projection.
- Draw front, top, and side views of simple engineering components.
- Read and interpret welding and fabrication drawings.
- Apply orthographic projection in workshop practice

Isometric Drawing

Isometric Drawing is a pictorial method of representing a **three-dimensional (3D) object** on a **two-dimensional (2D) drawing sheet**. In an isometric drawing, the three principal dimensions—**length, width, and height**—are shown simultaneously, making it easier to visualize the actual shape of an object.

In the **ITI Welder Trade**, isometric drawings are widely used for fabrication work, pipe layouts, structural steel work, machine components, and assembly drawings.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the principles of isometric drawing.
- Identify isometric axes and isometric planes.
- Draw simple engineering objects in isometric view.
- Convert orthographic views into isometric drawings.
- Read and interpret isometric fabrication drawings.
- Apply isometric drawing techniques in welding and fabrication.

Welding Symbols

Symbols are standardized graphical symbols used on engineering drawings to communicate welding requirements clearly and accurately. They provide complete information about the type of weld, size, length, location, finishing method, and other welding specifications without lengthy written instructions.

In the **ITI Welder Trade**, understanding welding symbols is essential for reading fabrication drawings, preparing welded joints, and ensuring that the weld is made according to engineering standards.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the purpose and importance of welding symbols.
- Identify the basic elements of welding symbols.
- Interpret different types of welding symbols.
- Read welding information from engineering drawings.
- Apply welding symbols in fabrication and workshop practice.

- Follow national and international welding standards.

Sectional Views

Sectional Views are special views used in engineering drawing to show the **internal details** of an object that cannot be seen clearly in normal orthographic views. A sectional view is obtained by imagining the object cut by an **imaginary cutting plane** and removing the front portion to expose the internal construction.

In the **ITI Welder Trade**, sectional views are widely used for understanding welded joints, pipe assemblies, machine parts, pressure vessels, structural components, and fabricated products.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the concept and importance of sectional views.
- Identify different types of sectional views.
- Interpret sectional drawings used in welding and fabrication.
- Draw sectional views of simple engineering components.
- Apply sectional views in engineering drawings and workshop practice.

Reading Fabrication Drawings

Sectional Views are special views used in engineering drawing to show the **internal details** of an object that cannot be seen clearly in normal orthographic views. A sectional view is obtained by imagining the object cut by an **imaginary cutting plane** and removing the front portion to expose the internal construction.

In the **ITI Welder Trade**, sectional views are widely used for understanding welded joints, pipe assemblies, machine parts, pressure vessels, structural components, and fabricated products.

Learning Objectives

After studying this unit, the trainee will be able to:

- Understand the concept and importance of sectional views.
- Identify different types of sectional views.
- Interpret sectional drawings used in welding and fabrication.
- Draw sectional views of simple engineering components.
- Apply sectional views in engineering drawings and workshop practice.

Blueprint Reading

Blueprint Reading is the process of understanding and interpreting engineering drawings, fabrication drawings, and technical plans used in manufacturing and construction industries. A blueprint provides complete information about the shape, size, dimensions, materials,

welding symbols, tolerances, and assembly details of a component. It serves as the primary communication tool between engineers, designers, supervisors, and welders. In the **ITI Welder Trade**, blueprint reading is an essential skill that enables trainees to correctly interpret fabrication drawings, identify welding joints, understand assembly sequences, and perform welding operations according to design specifications.

The study of blueprint reading includes understanding drawing sheets, title blocks, scales, projection methods, dimensions, symbols, sectional views, welding symbols, material specifications, tolerances, and assembly drawings. Trainees learn to identify different views such as front view, top view, side view, sectional view, and isometric view, along with reading dimensions, centre lines, hidden lines, cutting plane lines, and reference notes. The subject also covers the interpretation of fabrication drawings, pipe layouts, structural steel drawings, machine component drawings, and assembly drawings commonly used in industrial workshops.

WT-104 : Welding Technology & Materials

Ferrous Metals

Ferrous Metals are metals that contain **iron (Fe)** as their principal constituent. They are the most widely used engineering materials because of their high strength, durability, toughness, and excellent weldability. Ferrous metals play a significant role in the manufacturing, construction, automobile, railway, shipbuilding, and fabrication industries. In the **ITI Welder Trade**, knowledge of ferrous metals is essential for selecting suitable materials, choosing appropriate welding processes, selecting electrodes, and producing strong and defect-free welded joints.

Ferrous metals are generally classified into **Pig Iron, Cast Iron, Wrought Iron, Mild Steel, Carbon Steel, Alloy Steel, Stainless Steel, and Tool Steel**. **Pig Iron** is the crude form of iron obtained from the blast furnace and serves as the basic raw material for manufacturing cast iron and steel. **Cast Iron** contains a high percentage of carbon, possesses excellent casting properties, and is commonly used for machine beds, pipes, engine blocks, and heavy machine components. **Wrought Iron** is a nearly pure form of iron with very low carbon content, making it highly ductile, malleable, corrosion-resistant, and suitable for ornamental gates, railings, and decorative fabrication.

Non-Ferrous Metals

Non-Ferrous Metals are metals and alloys that **do not contain iron (Fe) as their principal constituent**. These metals are widely used in engineering industries because of their excellent corrosion resistance, light weight, high electrical and thermal conductivity, and non-magnetic properties. In the **ITI Welder Trade**, knowledge of non-ferrous metals is essential for selecting suitable materials, choosing appropriate welding techniques, and producing high-quality welds in industries such as aerospace, automobile, shipbuilding, electrical engineering, and chemical processing.

The most commonly used **non-ferrous metals** include **Aluminium, Copper, Brass, Bronze, Zinc, Tin, Lead, Nickel, Magnesium, and Titanium**. **Aluminium** is a lightweight metal with excellent corrosion resistance and high thermal conductivity. It is widely used in

aircraft, railway coaches, automobile bodies, pressure vessels, window frames, and marine structures. Aluminium requires special welding processes such as **TIG (GTAW)** and **MIG (GMAW)** because of its high thermal conductivity and oxide layer.

Welding Electrodes

Welding Electrodes are metallic rods or wires used to carry electric current and produce an electric arc during welding. They also provide filler metal to join two or more metal pieces permanently. Electrodes play a vital role in determining the strength, quality, and appearance of a welded joint. In the **ITI Welder Trade**, understanding welding electrodes is essential for selecting the correct electrode according to the type of metal, welding position, joint design, and service conditions.

Welding electrodes are mainly classified into **Consumable Electrodes** and **Non-Consumable Electrodes**. **Consumable electrodes** melt during welding and become part of the weld metal. They are commonly used in **Shielded Metal Arc Welding (SMAW)**, **MIG (GMAW)**, and **Submerged Arc Welding (SAW)**. **Non-consumable electrodes**, such as **Tungsten Electrodes**, do not melt during welding and are mainly used in **TIG (GTAW)** welding.

Electrodes may also be classified as **Bare Electrodes** and **Flux-Coated Electrodes**. Bare electrodes have no protective coating and are used only in limited applications. Flux-coated electrodes are covered with a protective layer called **flux**, which protects the molten weld metal from atmospheric contamination, stabilizes the arc, forms slag, and improves weld quality.

Welding Consumables

Welding Consumables are the materials that are consumed during the welding process to produce a strong and defect-free welded joint. These materials help in forming the weld metal, protecting the molten weld pool from atmospheric contamination, stabilizing the welding arc, and improving the mechanical properties of the weld. In the **ITI Welder Trade**, understanding welding consumables is essential for selecting the correct materials, achieving quality welds, and ensuring safety and efficiency in fabrication work.

The most common welding consumables include **welding electrodes, filler rods, welding wires, fluxes, shielding gases, backing strips, anti-spatter compounds, and brazing or soldering filler materials**. **Covered welding electrodes** are mainly used in Shielded Metal Arc Welding (SMAW), where the electrode melts to provide filler metal while its flux coating generates shielding gas and slag to protect the weld. **Filler rods** are commonly used in Gas Welding and TIG (GTAW), whereas **solid and flux-cored welding wires** are used in MIG/MAG (GMAW) and Flux-Cored Arc Welding (FCAW).

Shielding Gases

Shielding Gases are inert or semi-inert gases used during welding to protect the molten weld pool and the hot electrode from atmospheric contamination by oxygen, nitrogen, and hydrogen. These gases create a protective atmosphere around the welding arc, preventing oxidation, porosity, and other welding defects. In the **ITI Welder Trade**, shielding gases are

an essential part of modern welding processes such as **MIG (GMAW)**, **MAG (Metal Active Gas)**, **TIG (GTAW)**, **Plasma Arc Welding (PAW)**, and **Flux-Cored Arc Welding (FCAW)**. Proper selection of shielding gas improves weld quality, increases arc stability, enhances penetration, and produces smooth, clean weld beads.

Shielding gases are mainly classified into **Inert Gases**, **Active Gases**, and **Gas Mixtures**. **Inert gases** do not react chemically with the molten metal during welding. The most commonly used inert gases are **Argon (Ar)** and **Helium (He)**. Argon provides excellent arc stability, smooth weld appearance, and easy arc starting, making it suitable for welding aluminium, stainless steel, copper, titanium, and other non-ferrous metals. Helium produces a hotter arc with deeper penetration and is commonly used for thick materials and high-speed welding applications.

Welding Power Sources

Power Sources are electrical devices that supply the required **current (amperes)** and **voltage (volts)** to produce and maintain a stable electric arc during welding. They convert the available electrical energy into a controlled output suitable for different welding processes. In the **ITI Welder Trade**, understanding welding power sources is essential for selecting the correct machine, ensuring arc stability, producing high-quality welds, and operating welding equipment safely and efficiently.

The primary function of a welding power source is to provide sufficient electrical energy to melt the base metal and filler material while maintaining a stable arc. The performance of a welding machine directly affects weld penetration, bead appearance, welding speed, and overall weld quality. A suitable power source ensures smooth arc ignition, consistent heat input, reduced spatter, and improved productivity.

Corrosion

Corrosion is the gradual deterioration or destruction of a metal due to chemical or electrochemical reactions with its surrounding environment. It occurs when metals come into contact with moisture, oxygen, chemicals, acids, salts, or other corrosive substances, resulting in the formation of oxides or other compounds. In the **ITI Welder Trade**, understanding corrosion is essential because it affects the strength, durability, appearance, and service life of welded structures and engineering components. Proper knowledge of corrosion helps welders select suitable materials, apply protective measures, and produce long-lasting welded joints.

Corrosion occurs mainly because metals tend to return to their natural stable state by reacting with environmental elements. Common factors that accelerate corrosion include **moisture, oxygen, humidity, acids, alkalis, industrial pollutants, seawater, high temperature, and improper maintenance**. Welded joints may also become susceptible to corrosion if improper welding procedures, poor joint design, or unsuitable filler materials are used.

Heat Treatment

Heat Treatment is a controlled process of **heating and cooling metals or alloys** to change their physical and mechanical properties without altering their shape or chemical composition. It is carried out to improve the strength, hardness, toughness, ductility,

machinability, wear resistance, and internal structure of metals. In the **NCVT/ITI Welder Trade**, heat treatment is an important process because it enhances the performance of welded joints, relieves internal stresses, improves weld quality, and increases the service life of fabricated components.

The primary objectives of heat treatment are to improve mechanical properties, reduce internal stresses developed during welding or machining, increase hardness or toughness, improve machinability, enhance wear and corrosion resistance, and refine the grain structure of metals. Proper heat treatment also helps prevent distortion, cracking, and premature failure of welded structures.

Inspection & Testing

Inspection and Testing are essential quality control processes carried out to ensure that welded joints meet the required specifications, safety standards, and engineering requirements. Inspection involves examining the weld visually and dimensionally, while testing evaluates the strength, soundness, and performance of the welded joint using various methods. In the **ITI Welder Trade**, inspection and testing are vital for detecting welding defects, ensuring structural integrity, improving product quality, and preventing failures in service.

The primary objectives of inspection and testing are to verify the quality of welds, detect defects at an early stage, ensure compliance with engineering drawings and welding procedures, improve safety and reliability, reduce repair and rework costs, and increase the service life of welded structures. Proper inspection also helps maintain consistency in production and ensures that fabricated components meet national and international standards.

Welding Codes and Standards

Welding Codes and Standards are a set of established rules, specifications, guidelines, and technical requirements developed by national and international organizations to ensure that welding work is performed safely, consistently, and with the required level of quality. These codes specify the procedures for welding, inspection, testing, qualification of welders, materials, equipment, and quality control. In the **ITI Welder Trade**, knowledge of welding codes and standards is essential for producing reliable welded joints, maintaining industrial quality, ensuring workplace safety, and meeting customer and regulatory requirements.

The primary purpose of welding codes and standards is to establish uniform practices in welding operations, improve the quality and reliability of welded structures, prevent welding failures, ensure the safety of personnel and equipment, and facilitate inspection and certification. Compliance with these standards is mandatory in many industries such as construction, shipbuilding, oil and gas, power plants, pressure vessels, pipelines, railway engineering, automobile manufacturing, and heavy fabrication.

WT-105 : Practical Training

Workshop Safety

Workshop Safety refers to the rules, precautions, and safe working practices followed in a workshop to prevent accidents, injuries, fire hazards, and damage to equipment. It is one of

the most important aspects of the **ITI Welder Trade**, as welding involves high temperatures, electricity, compressed gases, ultraviolet radiation, sparks, fumes, and heavy machinery. Proper safety practices protect the welder, co-workers, equipment, and the workplace while ensuring efficient and accident-free operations.

The primary objective of workshop safety is to create a safe working environment by identifying hazards, minimizing risks, and encouraging safe work habits. Every welder should understand workplace hazards and strictly follow safety procedures before, during, and after welding operations. Safety begins with proper planning, correct use of equipment, and compliance with standard operating procedures.

Identification of Welding Equipment

Identification of Welding Equipment is the process of recognizing, understanding, and correctly using the various tools, machines, accessories, and safety devices required for welding operations. Proper identification of welding equipment is an essential skill for trainees in the **ITI Welder Trade**, as it enables them to select the correct equipment for different welding processes, operate machines safely, improve welding quality, and prevent workplace accidents.

A welding workshop contains several types of equipment, each designed for a specific purpose. The most important equipment is the **Welding Power Source**, which supplies the electrical energy required to produce and maintain the welding arc. Depending on the welding process, power sources may be AC, DC, transformer type, rectifier type, inverter type, or engine-driven welding machines.

Gas Welding

Gas Welding, also known as **Oxy-Acetylene Welding (OAW)**, is a fusion welding process in which heat is produced by burning a mixture of **oxygen and acetylene gases**. The flame generated by the welding torch melts the edges of the base metal and, when required, a filler rod is added to form a strong and permanent welded joint. Gas welding is one of the oldest and most widely used welding processes for joining thin metal sheets, pipes, tubes, and repair work. In the **ITI Welder Trade**, gas welding is an important practical skill because of its simplicity, portability, and versatility in fabrication and maintenance work.

The **principle of gas welding** is based on the combustion of oxygen and acetylene gases. When these gases are mixed in the correct proportion inside the welding torch and ignited, they produce a high-temperature flame of approximately **3,100°C to 3,300°C**, which melts the base metal at the joint. A suitable filler rod may be added to fill the joint gap, and upon cooling, a strong weld is formed.

Gas Cutting

Gas Cutting, also known as **Oxy-Fuel Cutting** or **Oxy-Acetylene Cutting**, is a thermal cutting process used to cut ferrous metals by using a high-temperature flame produced from a mixture of oxygen and a fuel gas, usually acetylene. In this process, the metal is first heated to its ignition temperature by the preheating flame, after which a stream of pure oxygen is directed onto the heated metal. The oxygen reacts with the metal, producing rapid oxidation

that removes the molten metal in the form of slag, thereby creating a clean cut. In the **ITI Welder Trade**, gas cutting is an essential practical skill widely used in fabrication, repair, dismantling, and maintenance work.

The **principle of gas cutting** is based on the oxidation of heated steel. Initially, the metal is heated to its ignition temperature (approximately **900°C**) using the oxy-acetylene flame. When the cutting oxygen lever is pressed, a jet of pure oxygen reacts with the hot metal, producing iron oxide and releasing additional heat. This continuous oxidation melts the metal, while the oxygen jet blows away the molten oxide, producing a narrow cut called the **kerf**.

SMAW Welding

Shielded Metal Arc Welding (SMAW), commonly known as **Manual Metal Arc (MMA) Welding** or **Stick Welding**, is one of the most widely used arc welding processes in the world. In this process, an electric arc is produced between a **flux-coated consumable electrode** and the workpiece. The heat generated by the arc melts both the base metal and the electrode, forming a molten weld pool. The flux coating on the electrode decomposes during welding to produce shielding gases and slag, which protect the molten weld metal from atmospheric contamination. After solidification, the slag is removed to reveal a strong and permanent welded joint. In the **ITI Welder Trade**, SMAW is considered a fundamental welding process because of its simplicity, versatility, low equipment cost, and wide industrial application.

The **principle of SMAW** is based on the generation of an electric arc between the coated electrode and the base metal. When the electrode touches the workpiece and is slightly withdrawn, an electric arc is established. The arc temperature, which ranges from approximately **5,000°C to 6,500°C**, melts the edges of the base metal and the electrode core wire. The molten electrode metal fills the joint, while the flux coating produces shielding gas and a protective slag layer that prevents oxidation and contamination. After cooling, the slag is chipped off to obtain the finished weld.

MIG Welding

Metal Inert Gas (MIG) Welding, also known as **Gas Metal Arc Welding (GMAW)**, is a semi-automatic or automatic arc welding process in which a **continuous consumable wire electrode** is fed through a welding gun while a **shielding gas** protects the molten weld pool from atmospheric contamination. An electric arc is formed between the continuously fed wire electrode and the workpiece, generating sufficient heat to melt both the electrode and the base metal. The molten metal solidifies to form a strong, clean, and permanent welded joint. In the **ITI Welder Trade**, MIG welding is one of the most important modern welding processes because of its high welding speed, excellent weld quality, ease of operation, and suitability for industrial mass production.

The **principle of MIG welding** is based on the generation of an electric arc between a continuously fed wire electrode and the base metal. The arc temperature, which ranges from approximately **5,000°C to 6,000°C**, melts the electrode wire and the edges of the workpiece. At the same time, a shielding gas surrounds the weld pool to prevent contamination from oxygen, nitrogen, and moisture in the atmosphere. Since the electrode is continuously

supplied, welding can be performed without interruption, resulting in high productivity and uniform weld quality.

TIG Welding

Tungsten Inert Gas (TIG) Welding, also known as **Gas Tungsten Arc Welding (GTAW)**, is a high-quality arc welding process in which a **non-consumable tungsten electrode** is used to produce an electric arc between the electrode and the workpiece. The molten weld pool is protected from atmospheric contamination by an **inert shielding gas**, usually **Argon** or **Helium**. If additional metal is required, a separate filler rod is manually fed into the weld pool. In the **ITI Welder Trade**, TIG welding is considered one of the most precise welding processes because it produces clean, strong, and high-quality welds with excellent appearance and minimal distortion.

The **principle of TIG welding** is based on the generation of an electric arc between the tungsten electrode and the base metal. The arc produces temperatures of approximately **6,000°C to 11,000°C**, which melt the base metal. Since the tungsten electrode has a very high melting point (about **3,422°C**), it does not melt during welding. An inert shielding gas continuously flows around the electrode and weld pool to prevent oxidation and contamination.

Fillet Welding

Fillet Welding is one of the most common and widely used welding techniques in fabrication and structural engineering. It is used to join two metal surfaces that meet at approximately **90 degrees** or at an angle without requiring edge preparation. The weld metal is deposited in the corner formed by the two workpieces, creating a **triangular cross-section** known as a fillet weld. In the **ITI Welder Trade**, fillet welding is considered a fundamental practical skill because it is extensively used in structural fabrication, bridges, shipbuilding, pressure vessels, pipelines, automobile manufacturing, and general engineering work.

The **principle of fillet welding** is based on melting the edges of the two workpieces and depositing filler metal in the joint area. During welding, the molten weld metal fuses with both base metals, forming a strong and permanent joint after solidification. Depending on the welding process used, the filler metal may be supplied by a coated electrode, continuous wire electrode, or filler rod.

Butt Welding

Butt Welding is one of the most common and important welding methods used to join **two metal pieces placed in the same plane with their edges facing each other**. The edges of the workpieces are aligned together and fused by applying heat with or without the addition of filler metal. Butt welding produces a strong, smooth, and permanent joint and is widely used in **structural fabrication, pipelines, pressure vessels, bridges, shipbuilding, railway engineering, automobile manufacturing, and heavy engineering industries**. In the **ITI Welder Trade**, butt welding is considered a fundamental welding technique because it forms the basis of many industrial fabrication and construction applications.

The **principle of butt welding** is based on melting the adjoining edges of two metal pieces by applying heat through a welding process such as **Shielded Metal Arc Welding (SMAW)**, **Metal Inert Gas (MIG/GMAW)**, **Tungsten Inert Gas (TIG/GTAW)**, **Gas Welding**, or **Submerged Arc Welding (SAW)**. The molten metal from the base material and filler material combines to form a homogeneous weld pool. After cooling and solidification, a strong joint is produced that is often as strong as or stronger than the parent metal.

Vertical Welding

Vertical Welding is a welding position in which the weld is made on a **vertical surface**, and the welding progresses either **from bottom to top (Vertical-Up)** or **from top to bottom (Vertical-Down)**. It is one of the four standard welding positions and requires greater skill than flat or horizontal welding because gravity affects the flow of molten metal. In the **ITI Welder Trade**, vertical welding is an important practical skill used in structural fabrication, shipbuilding, pressure vessels, pipelines, bridges, and construction projects where workpieces cannot be positioned flat.

The **principle of vertical welding** is to produce a sound and defect-free weld by carefully controlling the molten weld pool while welding on a vertical surface. The welder must maintain the correct arc length, electrode angle, travel speed, and weaving technique to prevent molten metal from sagging due to gravity. Proper heat control is essential to ensure complete fusion and adequate penetration.

Overhead Welding

Overhead Welding is a welding position in which the welding is performed **from the underside of the joint**, with the weld deposited on the lower surface of the workpiece. It is one of the most difficult welding positions because the molten weld metal tends to fall due to gravity. The welder must carefully control the welding arc, travel speed, electrode angle, and weld pool to produce a sound and defect-free joint. In the **ITI Welder Trade**, overhead welding is an advanced practical skill that is essential for structural fabrication, shipbuilding, pressure vessels, bridges, pipelines, power plants, and construction projects where components cannot be repositioned.

The **principle of overhead welding** is to join two metal pieces by creating an electric arc or gas flame that melts the base metal and filler metal while controlling the molten weld pool against the force of gravity. The welder maintains a short arc length and uses proper welding techniques to ensure complete fusion, adequate penetration, and uniform weld bead formation without excessive sagging or spatter.

Pipe Welding (Basic)

Pipe Welding is the process of joining two or more pipes permanently by melting and fusing their edges with or without the use of filler metal. It is one of the most important welding operations in industries such as **oil and gas, power plants, chemical industries, water supply systems, shipbuilding, construction, and structural fabrication**. In the **ITI Welder Trade**, basic pipe welding introduces trainees to pipe preparation, alignment, welding positions, joint types, welding techniques, and safety practices required for producing strong and leak-proof pipe joints.

The **principle of pipe welding** is similar to other fusion welding processes. Heat generated by an electric arc or gas flame melts the edges of the pipes and the filler material, forming a weld pool. After cooling, the molten metal solidifies and forms a permanent, strong, and pressure-resistant joint. Proper joint preparation, alignment, root gap, welding parameters, and welding technique are essential for obtaining sound welds with full penetration.

Sheet Metal Welding **Sheet Metal Welding** is the process of joining **thin metal sheets**, generally ranging from **0.5 mm to 6 mm** in thickness, by applying heat with or without filler metal to produce a permanent and strong joint. It is widely used in the fabrication of automobile bodies, aircraft components, household appliances, ducts, storage tanks, electrical cabinets, furniture, and light engineering products. In the **ITI Welder Trade**, sheet metal welding is an important practical skill because it requires precision, proper heat control, and suitable welding techniques to avoid distortion and burn-through while producing high-quality welds.

The **principle of sheet metal welding** is based on melting the edges of two thin metal sheets using a controlled heat source such as an electric arc or gas flame. The molten metal from the sheets, together with filler metal if required, forms a weld pool. After cooling, the weld pool solidifies to produce a strong and permanent joint. Since sheet metal is thin, careful control of heat input is essential to prevent excessive distortion, warping, or burn-through.

Fabrication Job

A **Fabrication Job** is the process of manufacturing or assembling metal components by **cutting, bending, shaping, fitting, and welding** them according to engineering drawings and specifications. Fabrication converts raw materials such as steel plates, pipes, bars, and structural sections into finished products used in construction, manufacturing, transportation, and heavy engineering industries. In the **ITI Welder Trade**, fabrication is one of the most important practical skills because it combines engineering drawing, measuring, marking, cutting, fitting, welding, grinding, and inspection to produce accurate and high-quality structures.

The **principle of fabrication** is to transform raw metal into a finished product by following a planned sequence of operations. The process begins with studying the engineering drawing and selecting suitable materials. Accurate measuring and marking are carried out before cutting the material to the required dimensions. The components are then shaped, assembled, aligned, tack welded, and finally welded permanently. After welding, finishing operations such as grinding, cleaning, inspection, and painting are performed to complete the fabrication job.

Grinding and Finishing

Grinding and Finishing are important post-welding operations performed to improve the appearance, accuracy, and quality of welded components. Grinding is the process of removing excess metal, slag, spatter, burrs, and surface irregularities using abrasive wheels or grinding machines, while finishing involves smoothing, cleaning, polishing, and preparing the welded surface for inspection, painting, coating, or final use. In the **ITI Welder Trade**, grinding and finishing are essential skills because they ensure that fabricated products meet dimensional accuracy, quality standards, and aesthetic requirements.

The **principle of grinding** is based on the removal of material by the action of rotating abrasive particles. As the grinding wheel rotates at high speed, its abrasive grains cut away small particles of metal from the workpiece, producing a smooth and uniform surface. Finishing operations are then carried out to remove minor imperfections, improve surface texture, and prepare the component for service or further processing.

Welding Inspection

Welding Inspection is the systematic examination of welded joints to ensure that they meet the specified quality, safety, and performance requirements. It is an essential part of quality control in welding because it helps identify defects, verify compliance with engineering drawings and welding procedures, and ensure that the welded structure is safe and reliable. In the **ITI Welder Trade**, welding inspection is an important skill that enables trainees to evaluate weld quality, detect defects at an early stage, and ensure that fabricated components satisfy industrial standards.

The primary objective of welding inspection is to verify that welded joints are free from defects, have the required dimensions, possess adequate strength, and conform to approved welding procedures and applicable codes. Proper inspection improves product quality, reduces repair costs, increases service life, and ensures the safe operation of welded structures.

Equipment Maintenance

Equipment Maintenance is the process of inspecting, cleaning, servicing, repairing, and maintaining welding equipment to ensure its safe, reliable, and efficient operation. Regular maintenance increases the life of welding machines, improves welding quality, reduces breakdowns, minimizes production delays, and ensures workplace safety. In the **ITI Welder Trade**, proper maintenance of welding equipment is an essential skill because well-maintained equipment produces stable arcs, high-quality welds, and safe working conditions.

The primary objective of equipment maintenance is to keep welding machines and accessories in good working condition, prevent unexpected failures, reduce repair costs, improve productivity, and ensure compliance with industrial safety standards. Proper maintenance also helps in maintaining consistent welding performance and reducing defects caused by faulty equipment.

Industrial Training

Industrial Training is a structured practical training programme conducted in industries, workshops, manufacturing units, fabrication plants, or service organizations to provide trainees with real workplace experience. It enables students to apply the theoretical knowledge and practical skills learned during their course in an actual industrial environment. In the **ITI Welder Trade**, industrial training is an essential component of skill development because it familiarizes trainees with modern welding technologies, industrial machinery, quality control systems, safety standards, production methods, and professional work culture.

The primary objective of industrial training is to bridge the gap between classroom learning and industrial practice. It helps trainees develop technical competence, improve practical

skills, understand industrial processes, enhance problem-solving abilities, and prepare for employment in the welding and fabrication industry. Industrial training also develops discipline, teamwork, communication skills, time management, and professional ethics.

WT-PRS : Sessional Assessment

Internal Assessment

Internal Assessment is a continuous evaluation process conducted by the training institute throughout the course to assess the trainee's knowledge, practical skills, discipline, attendance, safety awareness, and overall performance. Unlike the final examination, internal assessment measures the student's progress regularly during classroom teaching, workshop practice, assignments, and industrial training. In the **NCVT/ITI Welder Trade**, internal assessment plays an important role in ensuring that trainees develop the technical skills, professional attitude, and practical competence required for employment in the welding and fabrication industry.

The primary objective of internal assessment is to evaluate the trainee's learning continuously, identify strengths and weaknesses, encourage regular study habits, improve practical performance, and provide timely feedback for further improvement. It helps instructors monitor the overall development of trainees and ensures that learning outcomes are achieved effectively.

Practical Record

A **Practical Record** is an official document maintained by trainees to record all practical work, workshop exercises, experiments, fabrication jobs, observations, and industrial training activities performed during the course. It serves as a systematic record of the trainee's practical learning, technical skills, and progress throughout the training programme. In the **NCVT/ITI Welder Trade**, maintaining a practical record is compulsory because it demonstrates the trainee's practical competency, discipline, and understanding of various welding and fabrication processes. The practical record is regularly verified by instructors and forms an important part of the internal assessment and final practical examination.

The primary objective of maintaining a practical record is to document all workshop activities in a systematic manner, improve technical understanding, develop report-writing skills, encourage regular practice, and provide evidence of practical work completed during the course. It also helps trainees revise practical procedures before examinations and serves as a reference during industrial training and future employment.

Job File

A **Job File** is a systematic collection of all practical jobs, fabrication projects, workshop assignments, engineering drawings, inspection reports, and related documents completed by a trainee during the training programme. It serves as documentary evidence of the trainee's practical skills, technical knowledge, and progress throughout the course. In the **ITI Welder Trade**, maintaining a Job File is an important requirement because it demonstrates the trainee's competency in performing various welding and fabrication operations according to

industrial standards. The Job File is regularly verified by instructors and forms an important part of the **internal assessment, practical examination, and final trade evaluation**.

The primary objective of maintaining a Job File is to document every practical job completed during the course in an organized manner. It helps trainees develop technical documentation skills, improve record-keeping habits, maintain evidence of practical work, and prepare for employment and industrial training. The Job File also acts as a valuable reference for future fabrication and welding assignments.

Attendance

Attendance refers to the regular presence and active participation of trainees in theory classes, practical workshops, industrial training, seminars, and other academic activities throughout the course. It is an important part of the **ITI Welder Trade** because vocational education is primarily skill-based, and regular attendance is essential for developing practical competence, technical knowledge, and professional work habits. Attendance is also considered during **internal assessment**, practical examinations, and eligibility for the final trade test.

The primary objective of maintaining attendance is to ensure that trainees receive continuous theoretical instruction, practical training, and hands-on experience in welding and fabrication. Regular attendance helps trainees understand workshop procedures, improve technical skills, follow safety practices, and develop discipline and responsibility required in industrial workplaces.

Workshop Performance

Workshop Performance refers to the overall practical ability, technical skills, discipline, safety awareness, and professional attitude demonstrated by a trainee while performing workshop activities during the training programme. It is one of the most important evaluation criteria in the **ITI Welder Trade** because vocational education focuses primarily on developing practical competency through hands-on training. Workshop performance reflects how effectively a trainee applies theoretical knowledge in practical situations and performs welding and fabrication tasks according to industrial standards.

The primary objective of evaluating workshop performance is to assess the trainee's practical knowledge, technical competence, problem-solving ability, safety practices, and overall for industrial employment. Continuous evaluation helps instructors identify strengths and weaknesses, provide constructive feedback, and ensure that trainees achieve the required learning outcomes before completing the course.

Viva-Voce

Viva-Voce, commonly known as the **Oral Examination**, is an important method of assessing a trainee's theoretical knowledge, practical understanding, communication skills, and problem-solving ability through direct interaction with the examiner. In the **NCVT/ITI Welder Trade**, Viva-Voce is conducted along with practical examinations to evaluate whether the trainee possesses the necessary technical knowledge and practical competence

required to perform welding and fabrication work safely and efficiently in industrial environments.

The primary objective of Viva-Voce is to assess the trainee's understanding of welding principles, practical procedures, workshop safety, equipment operation, engineering drawings, welding defects, inspection techniques, and industrial practices. Unlike written examinations, Viva-Voce enables the examiner to evaluate the trainee's confidence, communication skills, analytical thinking, and ability to apply theoretical knowledge to practical situations.

Practical Examination

A **Practical Examination** is an assessment conducted to evaluate a trainee's practical knowledge, technical skills, workmanship, safety awareness, and ability to perform welding and fabrication tasks according to industrial standards. It is one of the most important components of the **ITI Welder Trade**, as vocational education focuses on developing practical competency through hands-on training. During the practical examination, trainees are required to demonstrate their ability to perform welding operations independently while following correct procedures, maintaining quality, and observing safety precautions.

The primary objective of the practical examination is to assess whether the trainee has acquired the necessary skills to perform welding and fabrication work safely, accurately, and efficiently. It evaluates the trainee's ability to apply theoretical knowledge in practical situations, operate welding equipment correctly, produce quality welds, inspect completed jobs, and solve practical problems commonly encountered in industrial workshops.

Project Work

Project Work is a practical assignment in which trainees plan, design, fabricate, inspect, and complete a welding or fabrication project by applying the theoretical knowledge and practical skills acquired during the training programme. It is one of the most important components of the **ITI Welder Trade** because it provides an opportunity to perform a complete fabrication job under conditions similar to those found in industry. Project work helps trainees develop technical competence, creativity, teamwork, problem-solving ability, and professional work habits required in modern manufacturing and fabrication industries.

The primary objective of project work is to enable trainees to apply classroom learning to real engineering problems, improve practical skills, develop confidence in handling welding equipment, and gain experience in planning and executing fabrication jobs independently. It also helps trainees understand industrial work procedures, quality standards, documentation, and time management.

Safety Compliance

Safety Compliance refers to the process of following all prescribed **safety rules, regulations, standards, and procedures** while performing welding and fabrication work. It ensures that all welding operations are carried out in a safe manner to protect workers, equipment, property, and the environment from accidents and hazards. In the **ITI Welder Trade**, safety compliance is one of the most important aspects of training because welding

involves electricity, high temperatures, ultraviolet radiation, compressed gases, molten metal, sparks, fumes, and heavy machinery. Strict adherence to safety requirements minimizes workplace accidents and ensures efficient industrial operations.

The primary objective of safety compliance is to create a safe working environment by identifying hazards, reducing risks, preventing accidents, and ensuring that all workshop activities are performed according to approved safety standards. It also helps industries comply with legal requirements and maintain a healthy workplace for employees.

Trade Test

A **Trade Test** is the final competency-based examination conducted to evaluate a trainee's theoretical knowledge, practical skills, technical competence, and professional attitude after completing the training programme. It is one of the most important assessments in the **ITI Welder Trade**, as it determines whether the trainee has acquired the knowledge and practical skills required to work as a qualified welder in industries. The Trade Test is designed according to national skill standards and assesses the trainee's ability to perform welding and fabrication work safely, accurately, and efficiently under industrial conditions.

The primary objective of the Trade Test is to verify that trainees have achieved the prescribed learning outcomes and possess the technical competence required for employment. It evaluates not only welding skills but also the trainee's understanding of engineering drawings, workshop safety, welding procedures, quality control, equipment maintenance, and industrial practices. Successful completion of the Trade Test leads to certification, which enhances employability in both government and private sectors.

Reference Books

1. **NCVT Welder Trade Theory**
2. **Welder Trade Practical – DGT**
3. **O.P. Khanna – Welding Technology**
4. **Welding Handbook – American Welding Society (AWS)**
5. **Elements of Workshop Technology – S.K. Hajra Choudhury**
6. **Engineering Drawing – N.D. Bhatt**
7. **IS Codes for Welding (BIS)**
8. **Safety in Welding – OSHA Guidelines**
9. **Workshop Calculation & Science – DGT**
10. **Engineering Materials – R.K. Rajput**